
FORWARD SENSING CAMERA (FSC)

id151100001100

Purpose

- The forward sensing camera (FSC) recognizes light-emitting objects, vehicle lane lines, vehicles ahead, pedestrians, obstructions, and signs based on the images picked up at the front of the vehicle, and controls each system.

Function

Note

- In the following cases, the FSC may not be able to detect target objects correctly.
 - Under bad weather condition, such as rain, fog and snow.
 - The window washer is being used or the windshield wipers are not used when it's raining.
 - Ice, fog, snow, frost, rainfall, dirt, or foreign matter such as a plastic bag is stuck on the windshield.
 - Trucks with low loading platforms and vehicles with an extremely low or high profile.
 - When driving next to walls with no patterning (including fences and longitudinally striped walls).
 - The taillights of the vehicle ahead are turned off.
 - A vehicle is outside the illumination range of the headlights.
 - The vehicle is making a sharp turn, or ascending or descending a steep slope.
 - Entering or exiting a tunnel.
 - Heavy luggage is loaded causing the vehicle to tilt.
 - Strong light is shone at the front of the vehicle (back light or high-beam light from on-coming vehicles).
 - There are many light emitters on the vehicle ahead.
 - When the vehicle ahead is not equipped with taillights or the taillights are turned off at nighttime.
 - Elongated luggage or cargo is loaded onto installed roof rails and covers the FSC.
 - Exhaust gas from the vehicle in front, sand, snow, and water vapor rising from manholes and grating, and water splashed into the air.
 - When towing a malfunctioning vehicle.
 - The vehicle is driven with tires having significantly different wear.
 - The vehicle is driven on down slopes or bumpy roads.
 - There are water puddles on the road.
 - The surroundings are dark such as during the night, early evening, or early morning, or in a tunnel or indoor parking lot.
 - The illumination brightness of the headlights is reduced or the headlight illumination is weakened due to dirt or a deviated optical axis.
 - The target object enters the blind spot of the FSC.
 - A person or object bursts onto the road from the shoulder or cuts right in front of you.
 - You change lanes and approach a vehicle ahead.
 - When driving extremely close to the target object.
 - Tire chains or a temporary spare tire is installed.
 - The vehicle ahead has a special shape. For example, a vehicle towing a trailer house or a boat, or a vehicle carrier carrying a vehicle with its front pointed rearward.

Light-emitting object (on-coming vehicle, vehicle ahead, street lights) recognition function

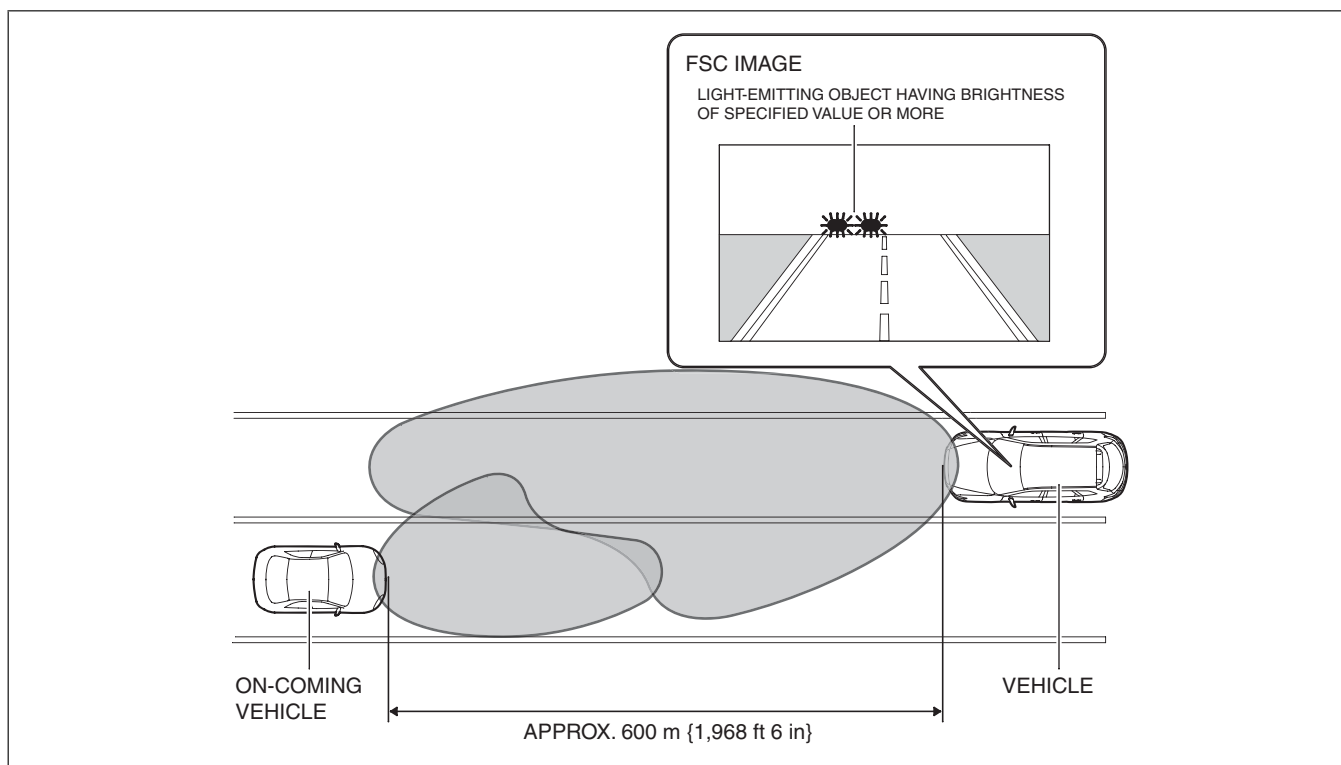
- Analyzes the light-emitting object picked up by the camera, and recognizes it as an on-coming vehicle, vehicle ahead, or street lights (traveling on town/city streets).

On-coming vehicle recognition function

- The forward sensing camera (FSC) recognizes a light-emitting object which meets any of the following conditions and is at least **within 600 m {1,968 ft 6 in}** from the detecting vehicle as an on-coming vehicle.
 - Light-emitting object approaches having brightness of specified value or more
 - Light-emitting object approaches having white color and certain level of brightness or more (if it approaches and brightness changes, determination made at point of image capture)

Note

- If the on-coming vehicle and the surrounding conditions are as follows, the forward sensing camera (FSC) may require time until it recognizes an on-coming vehicle.
 - Poor visibility due to rain and fog
 - On-coming vehicle is travelling with only TNS or fog lights
 - Brightness of light source is low, such as a bicycle



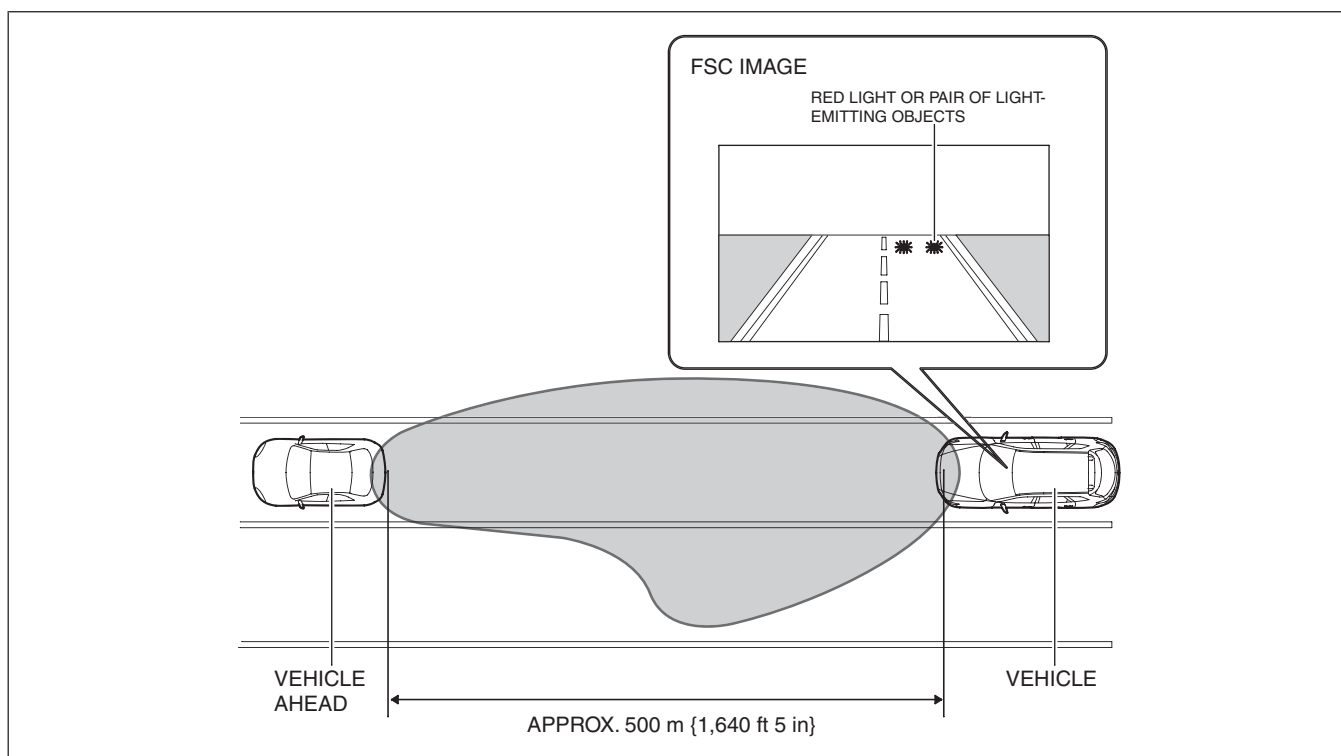
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Vehicle ahead recognition function

- The forward sensing camera (FSC) recognizes a light-emitting object which meets any of the following conditions and is at least **within 500 m {1,640 ft 5 in}** from the detecting vehicle as a vehicle ahead.
 - Red light emitted from light-emitting object is detected
 - Determines that there is a pair of light-emitting objects

Note

- The system could recognize reflecting objects on the road surface or a guard rail as a vehicle ahead (switches headlights to low beams).
- If visibility is poor due to rain or fog, the system may not recognize a vehicle ahead even though one may exist (maintains headlight high beams).



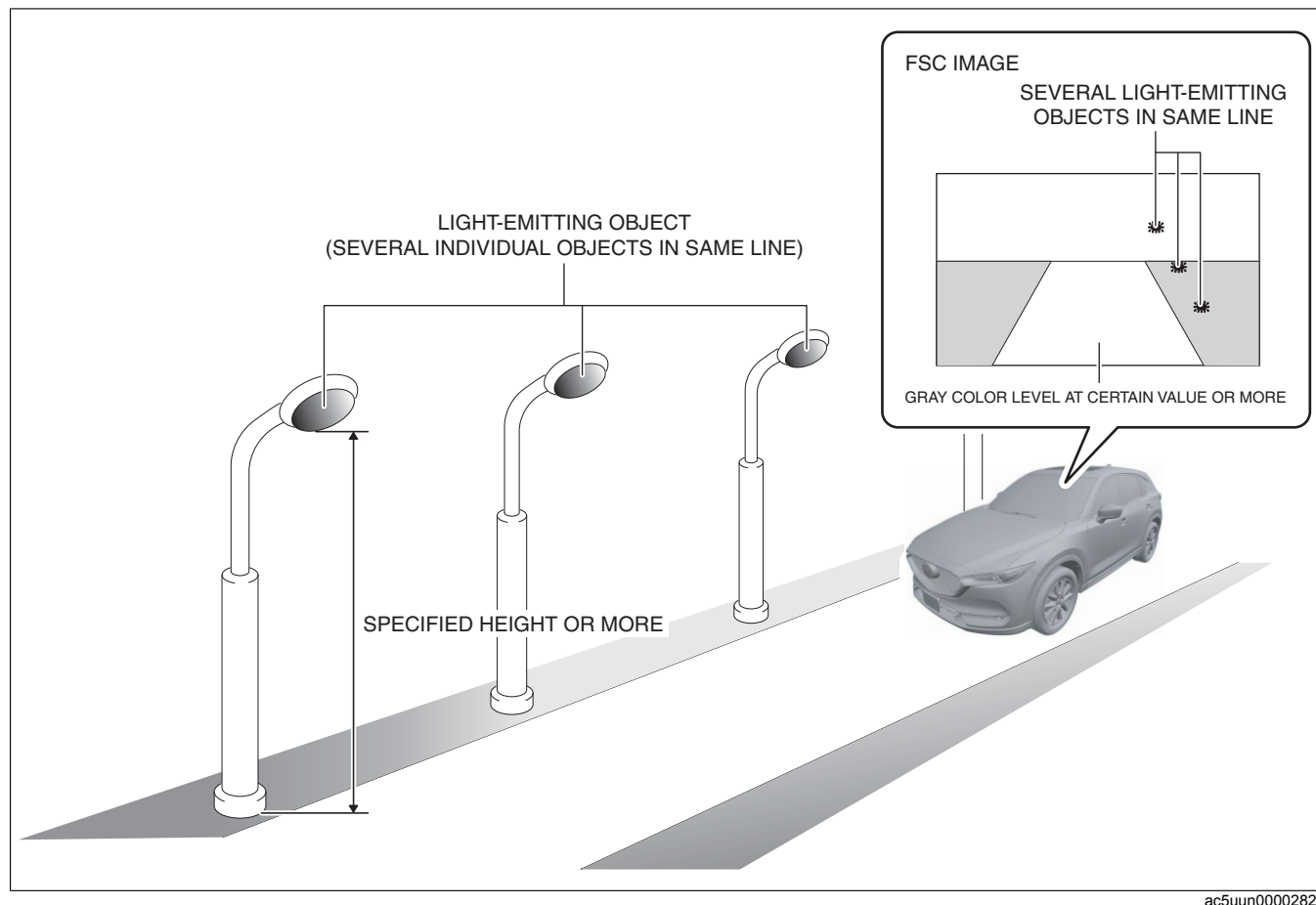
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Town/city streets recognition function

- In the following cases, the forward sensing camera recognizes that the vehicle is traveling on town/city streets.
 - Several light-emitting objects of certain height or more from road surface along same line are detected
 - Camera image gray color is certain level or more

Note

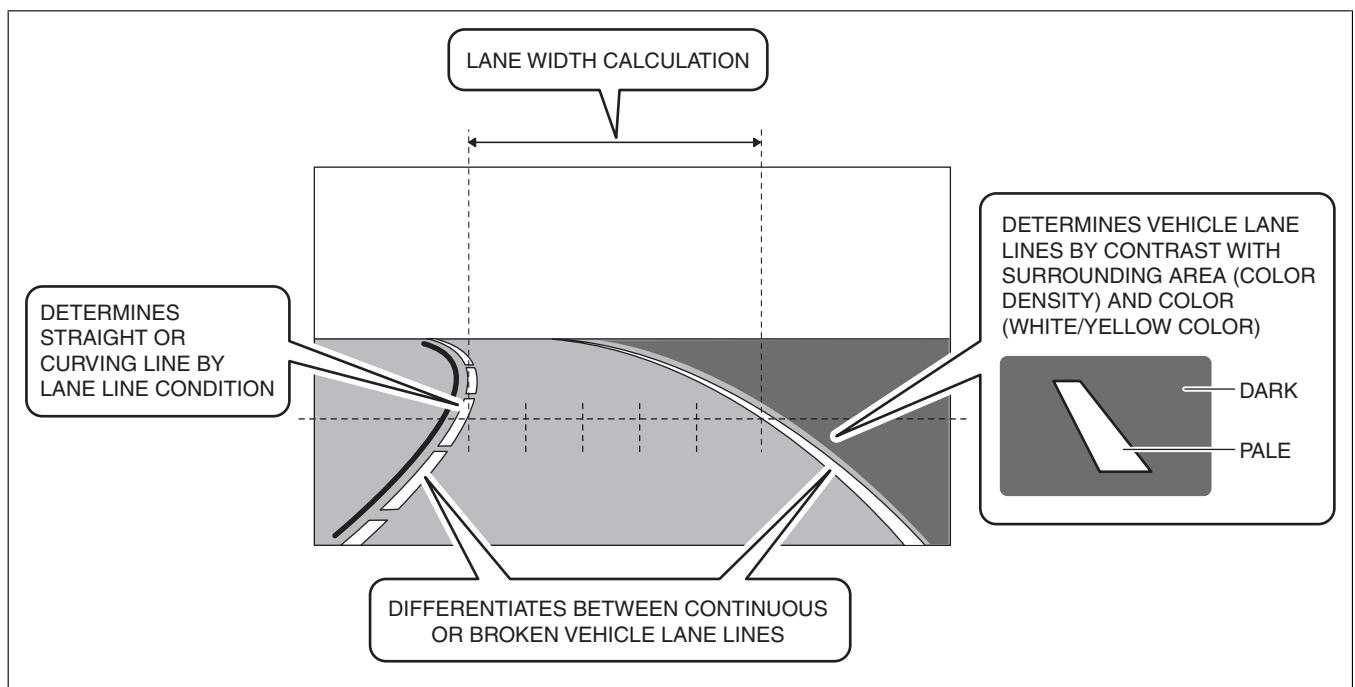
- Even during travel other than on town/city streets at night, if the road surface is bright from moonlight, the system may recognize that the vehicle is traveling on town/city streets (switches headlights to low beams).



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Vehicle lane lines and travel lane recognition function

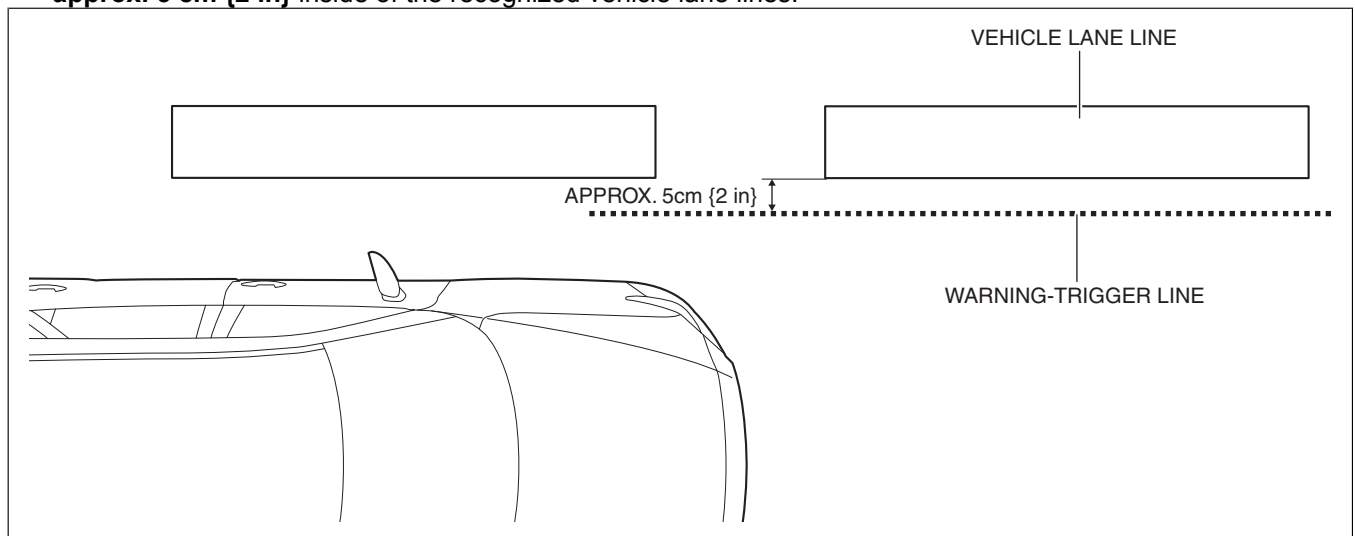
- The forward sensing camera (FSC) recognizes lineal objects which are white/yellow and paler than the surrounding color as vehicle lane lines by the contrast (color density) of the camera image.
- If the vehicle lane lines are continuous they are recognized as actual lines, if discontinuous they are recognized as broken lines.
- The travel lanes recognized from the vehicle lane lines on the left and right of the vehicle are used to calculate the width.
- Traveling in a straight line or cornering is determined by the status of the vehicle lane lines.



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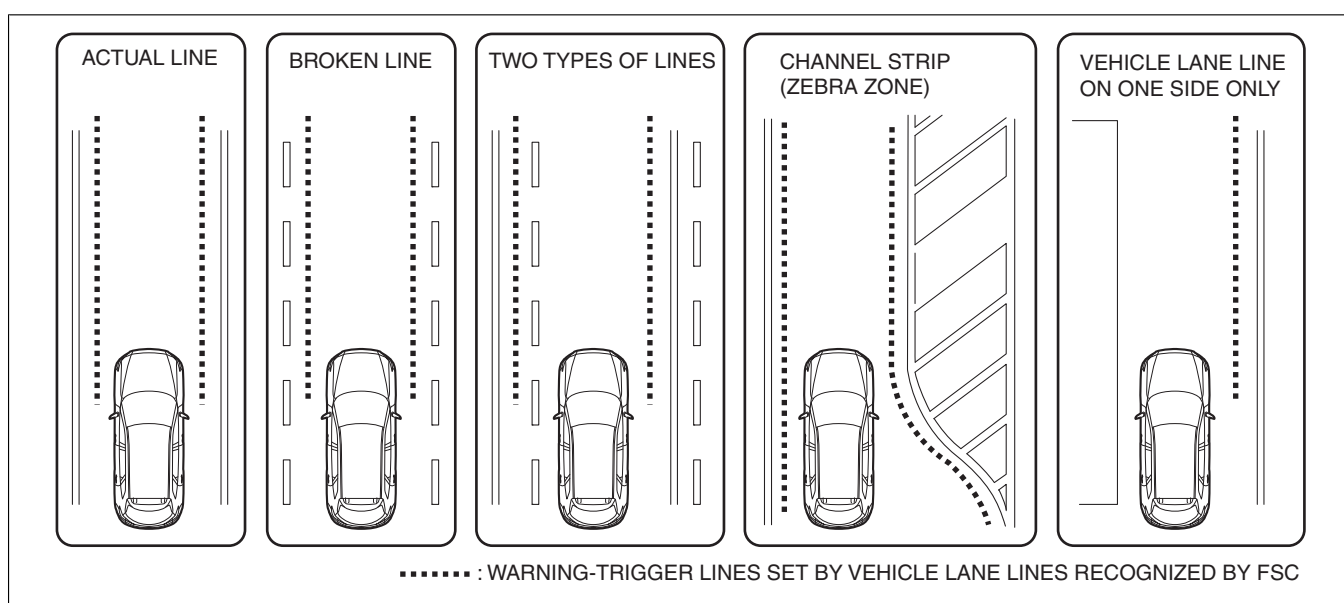
LDWS warning-trigger line setting function

- The forward sensing camera (FSC) sets the lane departure warning system (LDWS) warning-trigger lines^{*1} at **approx. 5 cm {2 in}** inside of the recognized vehicle lane lines.



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- If there is only one vehicle lane line or only one vehicle lane line can be recognized, the warning-trigger line is set to only the recognized vehicle lane line.
- If a broken line and solid line are both recognized, the solid line is given priority to be set to the warning-trigger line.



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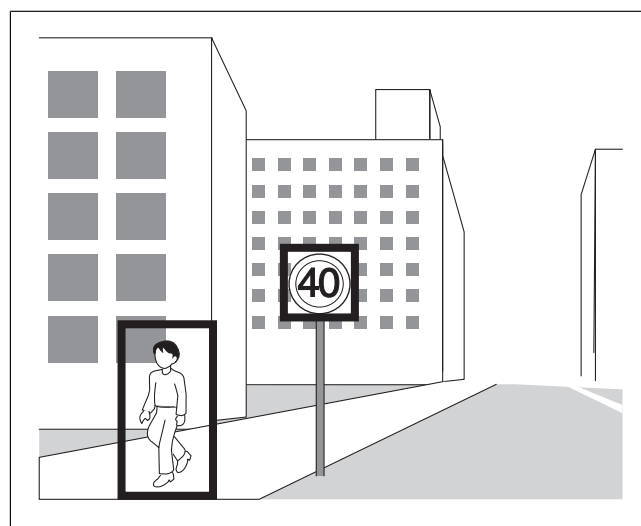
*1 : The distance between the vehicle lane lines and the warning-trigger lines can be changed using the personalization feature. For details, refer to [INSTRUMENTATION/DRIVER INFO. PERSONALIZATION]. (See INSTRUMENTATION/DRIVER INFO. PERSONALIZATION.)

Pedestrian and traffic sign recognition function

- The forward sensing camera (FSC) recognizes pedestrians and traffic signs based on the camera image.

Note

- Under the following conditions, the Traffic Sign Recognition System (TSR) may not operate normally.
 - The camera cannot capture a traffic sign's image.
 - A traffic sign is too bright or too dark (including electronic traffic signs).

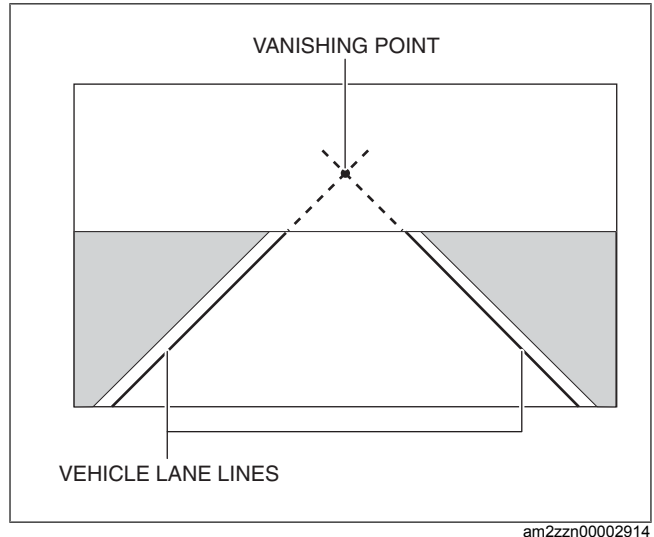


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Aiming correction function

- The forward sensing camera (FSC) adjusts the camera shot angle by aiming, and stores the vanishing point*1. The stored vanishing point and the current vanishing point are compared and if there is a deviation of a certain value or more in the vanishing point, the current vanishing point is stored as the new vanishing point.

*1 : The vehicle lane lines on the road surface are parallel and do not intersect, however, when viewed by the camera image, the lines converge in the distance and eventually cross. The point at which the lines cross is called the vanishing point.



HBC warning light (amber), smart city brake support (SCBS) indicator light/smart city brake support (SCBS) warning light burnt out bulb check function

- When the ignition is switched ON (engine off or on), the instrument cluster turns the HBC warning light (amber), smart city brake support (SCBS) indicator light/smart city brake support (SCBS) warning light on for **approx. 3 s** to check for burnt out bulb.

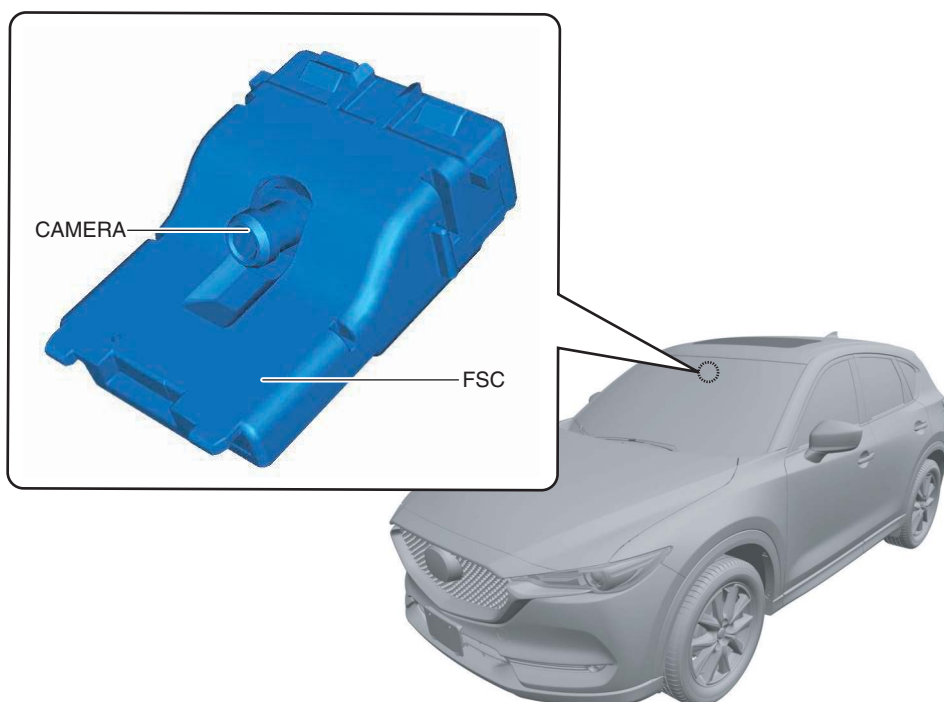
On-board diagnostic function

- The forward sensing camera (FSC) detects dirt and fogging of the camera lens and windshield glass, forward sensing camera (FSC) communication errors, forward sensing camera (FSC) internal malfunctions, and outputs DTCs. For details on DTCs, refer to [ON-BOARD DIAGNOSTIC [FORWARD SENSING CAMERA (FSC)]]. (See ON-BOARD DIAGNOSTIC [FORWARD SENSING CAMERA (FSC)].)

Construction

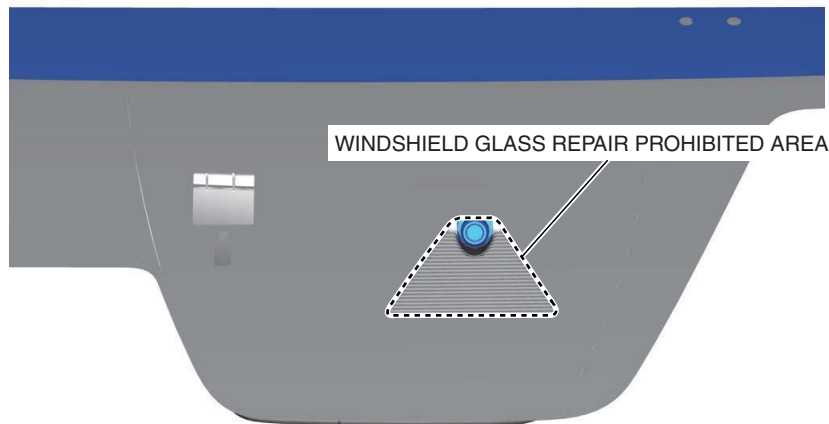
- The forward sensing camera (FSC) is positioned on the windshield.
- By integrating a small, color CMOS camera^{*1} with the control module, lightness and size reduction have been achieved.
- The forward sensing camera (FSC) communicates with other modules via CAN.

^{*1} : Camera equipped with high sensitivity CMOS (Complementary Metal-Oxide Semiconductor) image sensor



Note

- If there is damage or cracking in the windshield glass repair prohibited area, replace the windshield. If the damage or cracking in the windshield glass repair prohibited area is repaired, it could affect the recognition of the Forward Sensing Camera (FSC) and the system may not operate normally.



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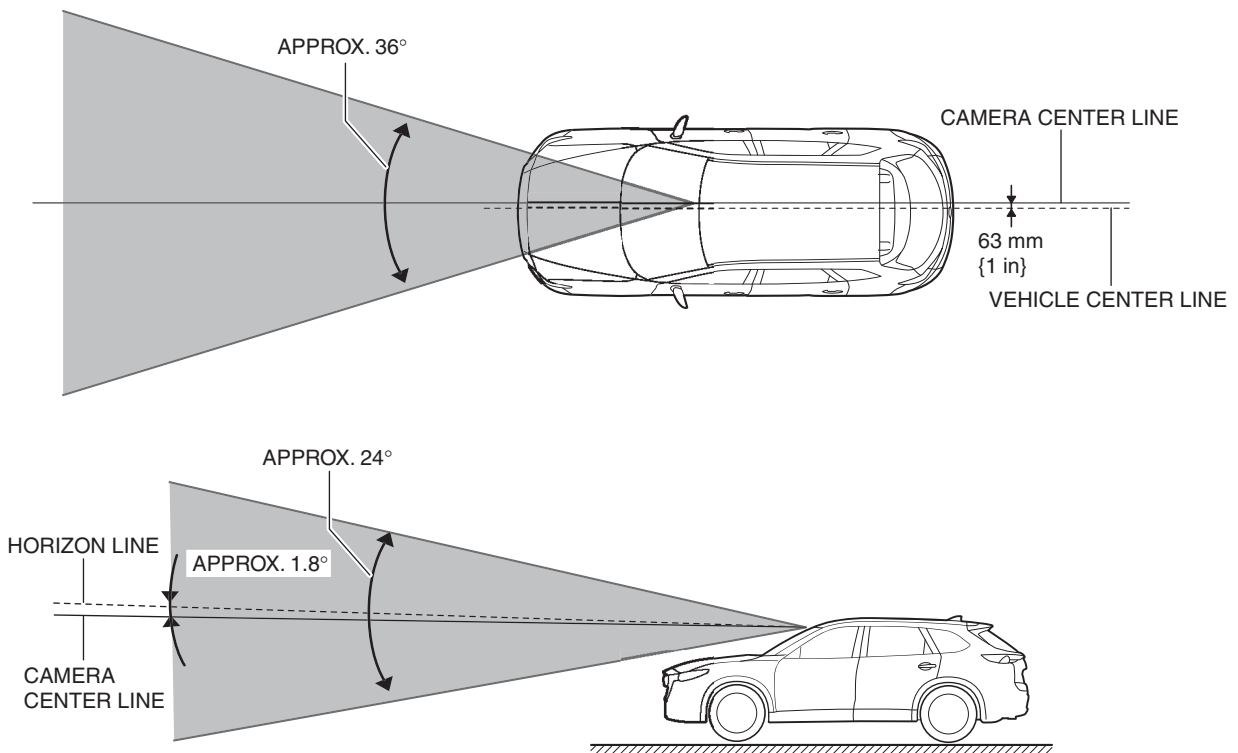
Operation

Camera range

- The forward sensing camera (FSC) shoots in the following range.

Note

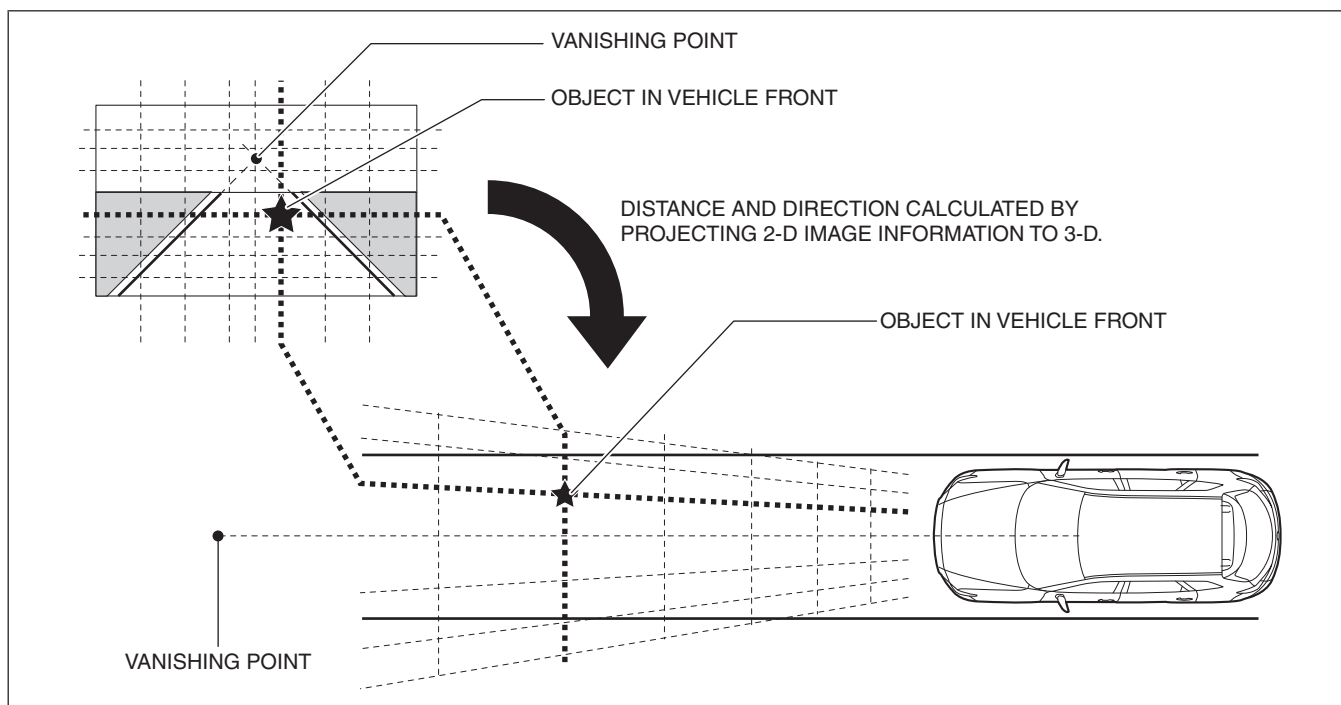
- Depending on the surrounding conditions (ascending roads, winding roads, walls), the forward sensing camera (FSC) may be unable to pickup an object in front of the vehicle within the camera range and not recognize it as a controlled target object.



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Position calculation

- When an object appears on the screen, the forward sensing camera (FSC) determines the position coordinates and calculates the direction and distance to the object.



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Fail-safe

Lane-keep assist system/Lane departure warning system (LDWS)

- Stops the system function.

Advanced smart city brake support (advanced SCBS)

- Stops the system function.

High beam control (HBC) system

- Refer to fail-safe for [HIGH BEAM CONTROL (HBC) SYSTEM]. (See HIGH BEAM CONTROL (HBC) SYSTEM.)